# An Overview of the Williams Fork Formation Reservoir Characterization at Mamm Creek Field, Piceance Basin, Colorado

**Matthew J. Pranter, Alicia Hewlett, Sait Baytok, Rachel Shaak**

Reservoir Characterization and Modeling Laboratory

RCML

EMARC

Energy and Minerals Applied Research Center

*University of Colorado at Boulder*

# Outline

I. Research Objectives

II. Study Area

III. 3-D Reservoir Characterization and Modeling of Matrix Properties

IV. Seismic Interpretation, Fracture Analysis, and Fracture Modeling

V. Conclusions

# Research Objectives

- **Within the southeastern Piceance Basin and Mamm Creek Field, how does the lower Williams Fork Formation vary in terms of stratigraphic architecture, shoreline stacking patterns, and lithology?**

- **For the Williams Fork Formation at Mamm Creek Field, what is the stratigraphic variability of sandstone-body type and distribution, matrix reservoir quality, and static connectivity?**

- **For the Williams Fork Formation at Mamm Creek Field, what are the main fault types and their distribution and how does fracture distribution vary with faulting, lithology, architectural elements and other parameters?**

# Study Area and Focus

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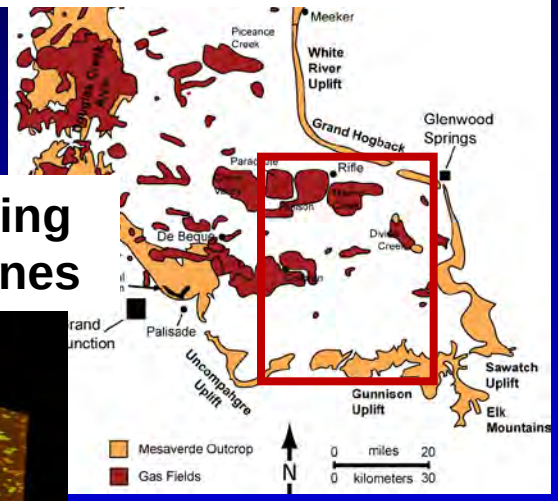
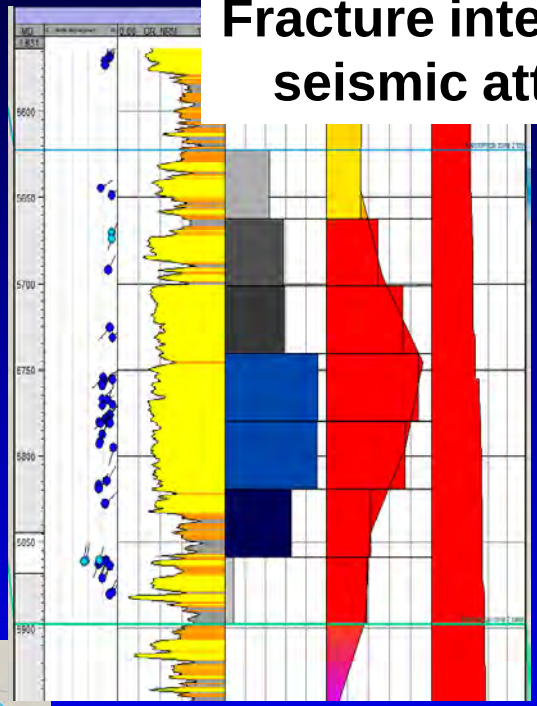
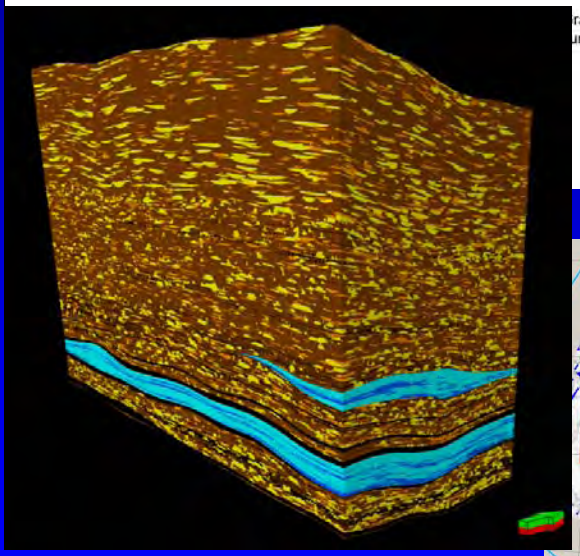
**Regional distribution of coastal plain and marine deposits**

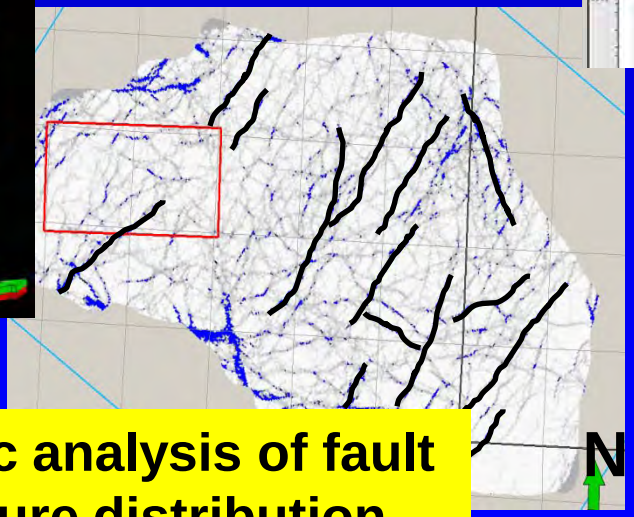



**Fracture intensity and seismic attributes**

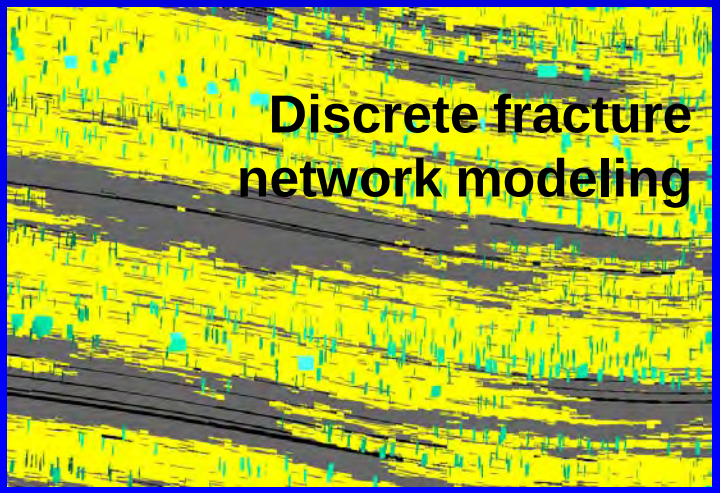


**3-D reservoir modeling of tight-gas sandstones**



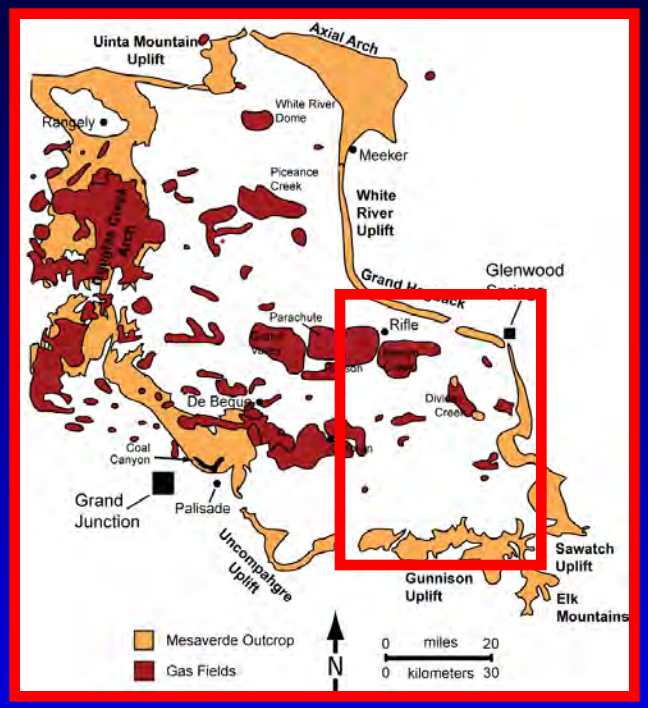



**3-D seismic analysis of fault and fracture distribution**

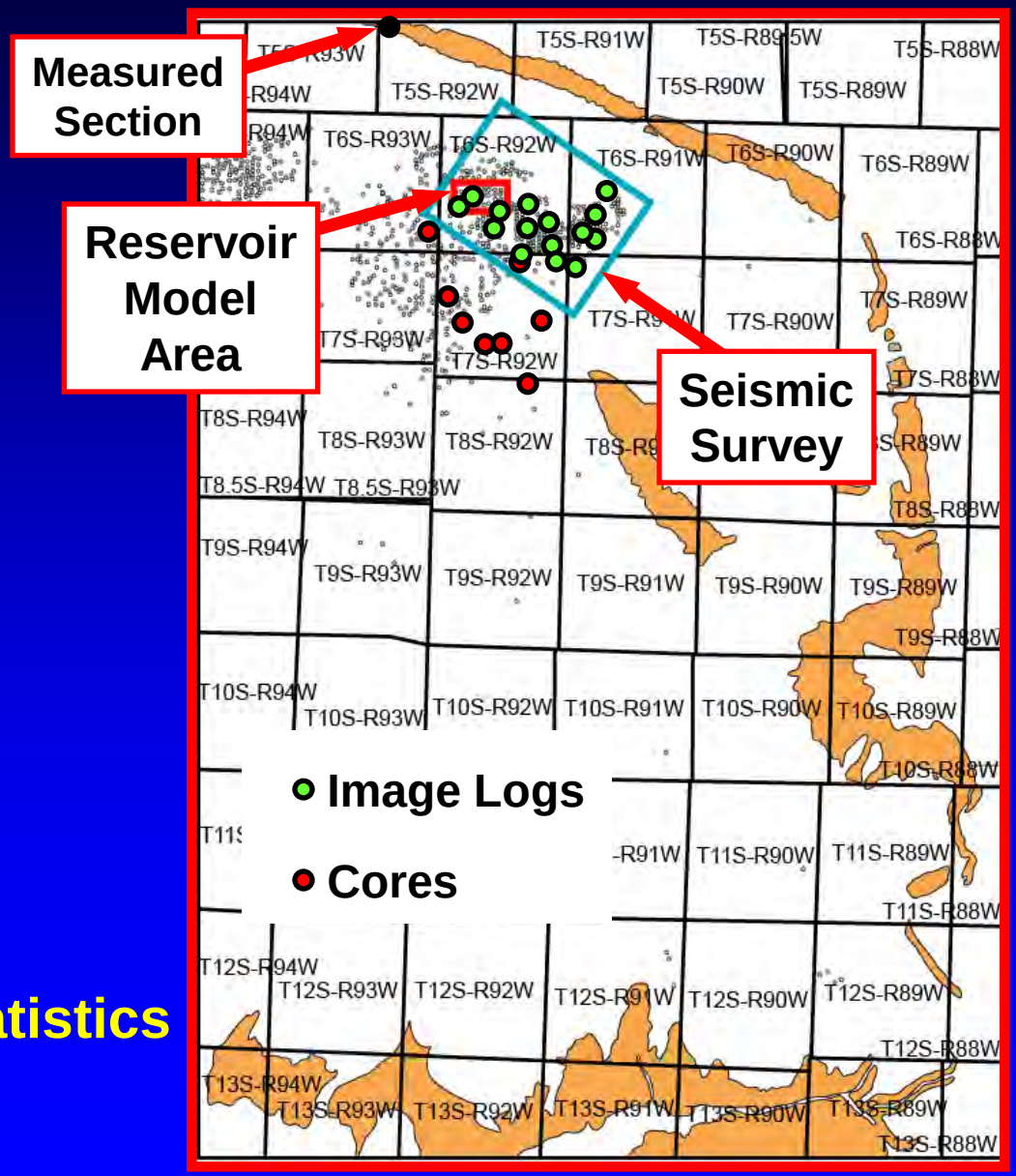


**Discrete fracture network modeling**

# Study Area and Focus




- data from 1,400 wells
- 3-D seismic survey
- 8 cores
- 12 borehole image logs
- outcrop sandstone-body statistics
- measured section



# Reservoir Characterization and Modeling

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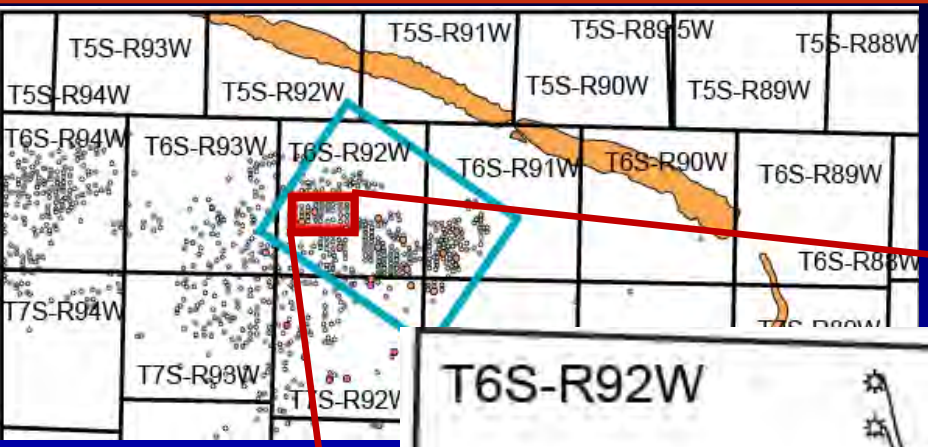
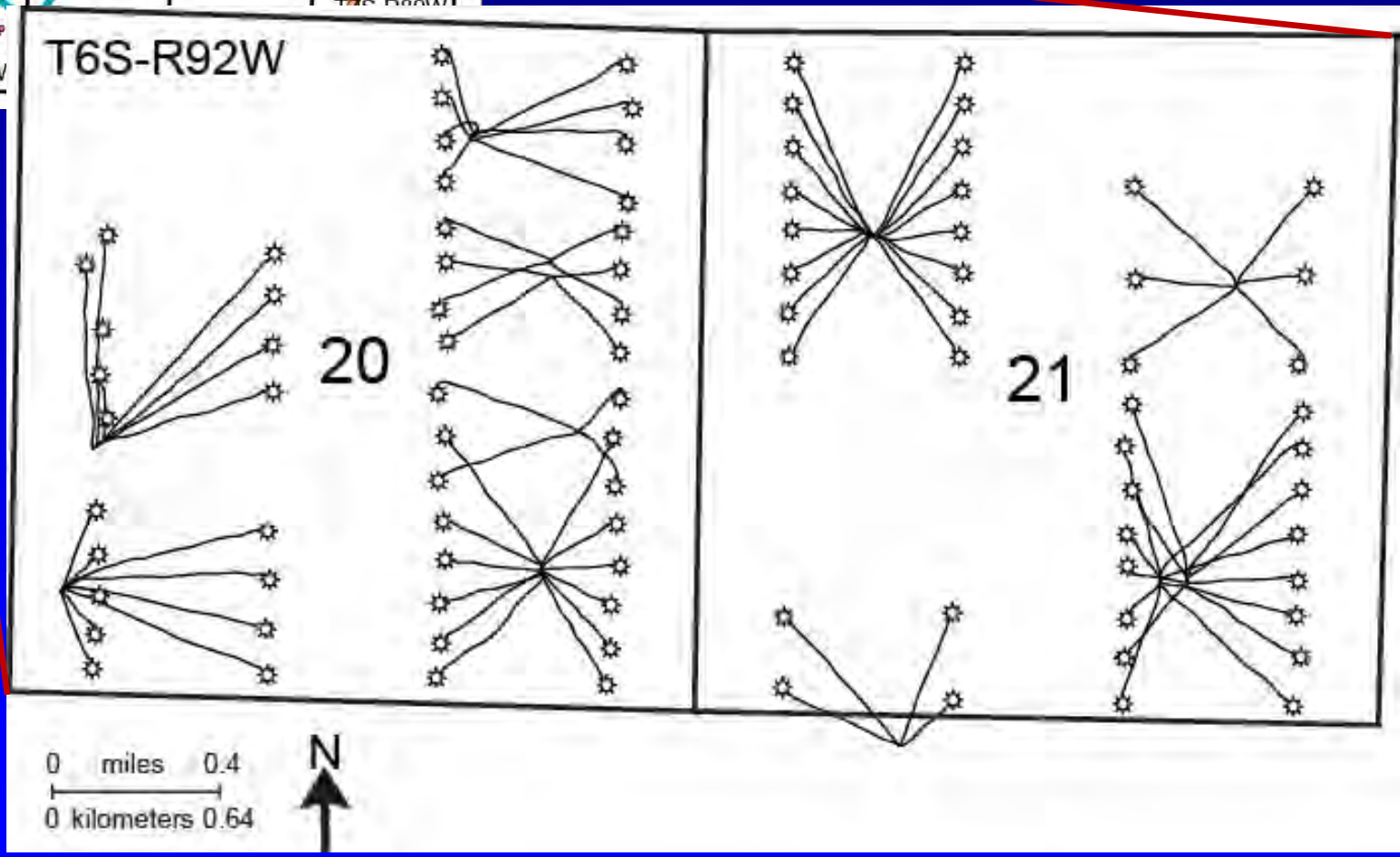



**2 mi²**
**91 wells**
**irregular 10-acre density**



# Stratigraphic Interval for Reservoir Modeling

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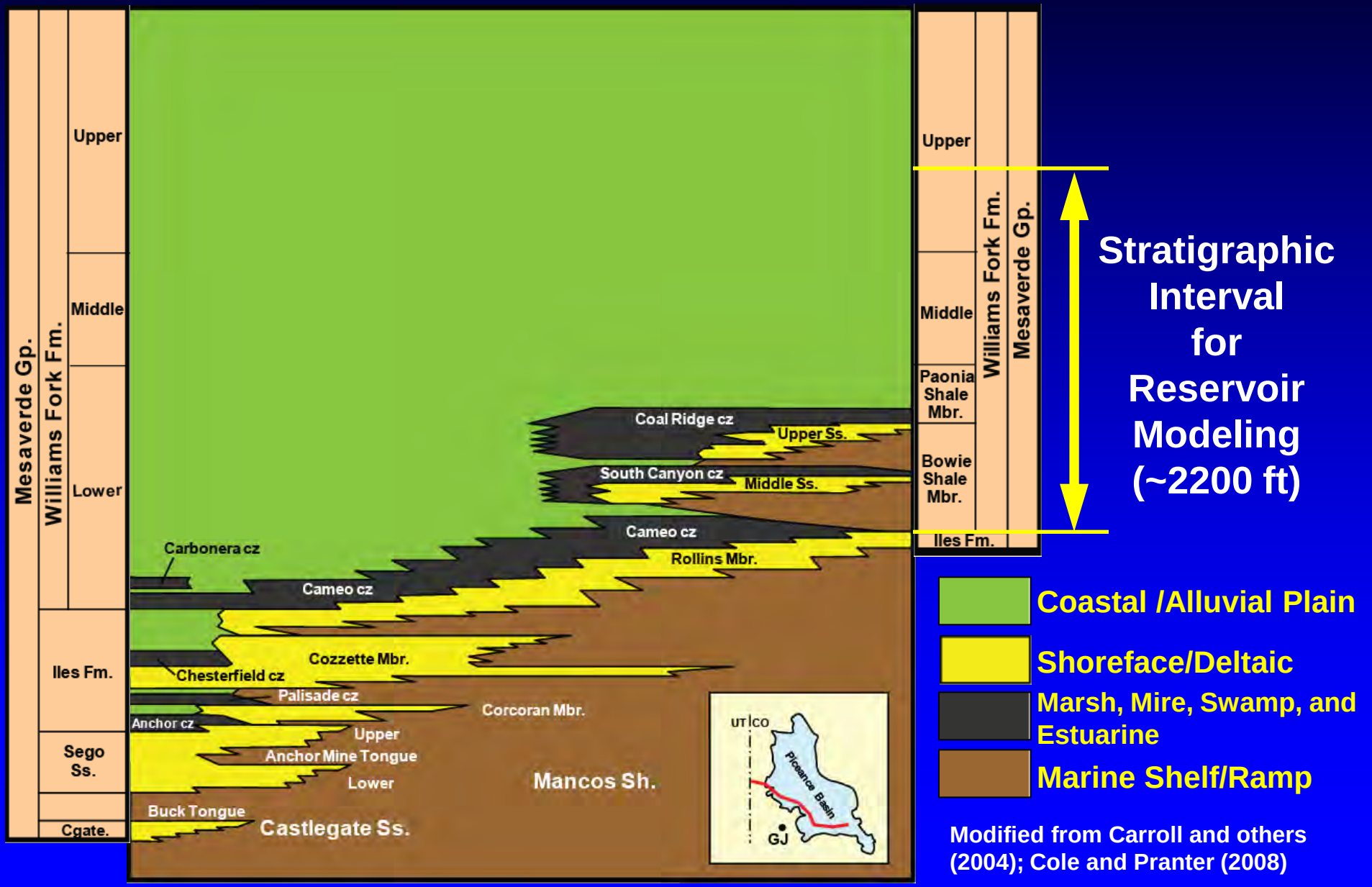
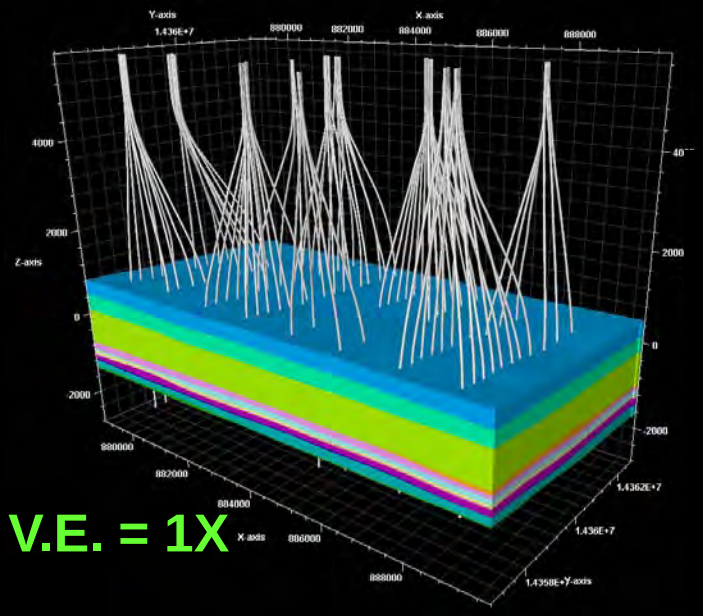
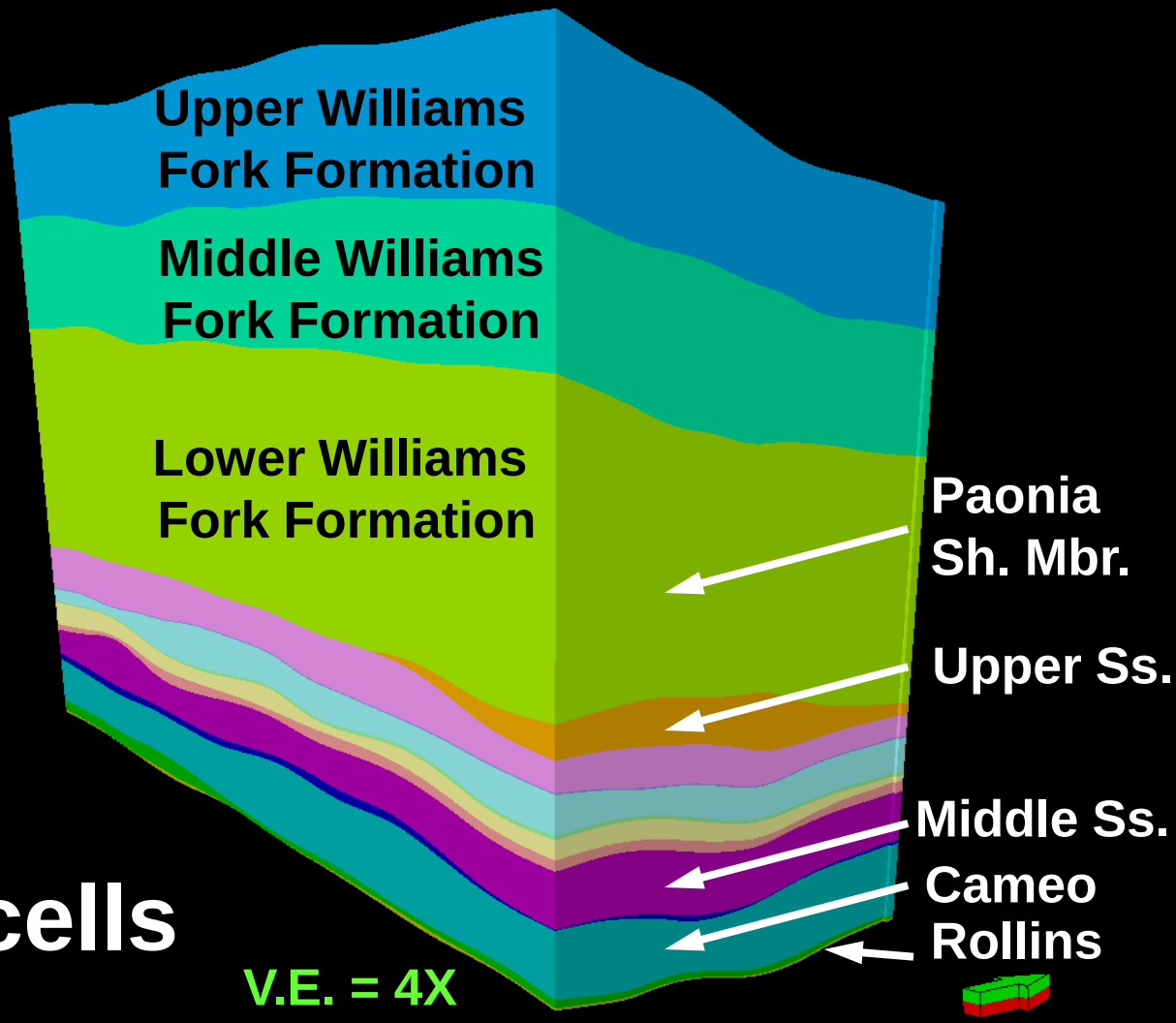



Modified from Carroll and others (2004); Cole and Pranter (2008)

# Model Framework




- 91 wells
- 15 zones
- 40’ x 40’ x 1’
- 89.4 million cells



# Model Inputs and Constraints

## Calculated Lithology logs

sandstone/
clean sandstone

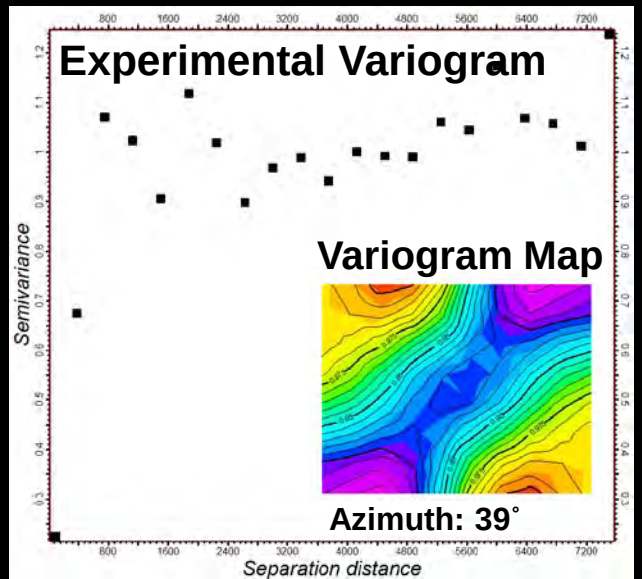
shaley
sandstone

## Interpreted Architectural Element Logs

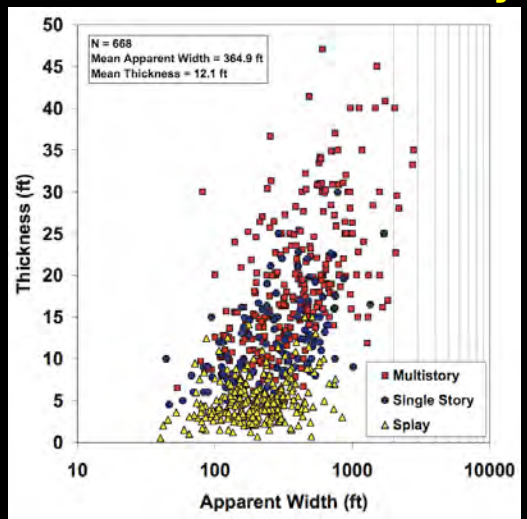
crevasse
splay

point
bar

## Variography




## Outcrop dimensional statistics and object shapes




# Architectural Element Object Shapes

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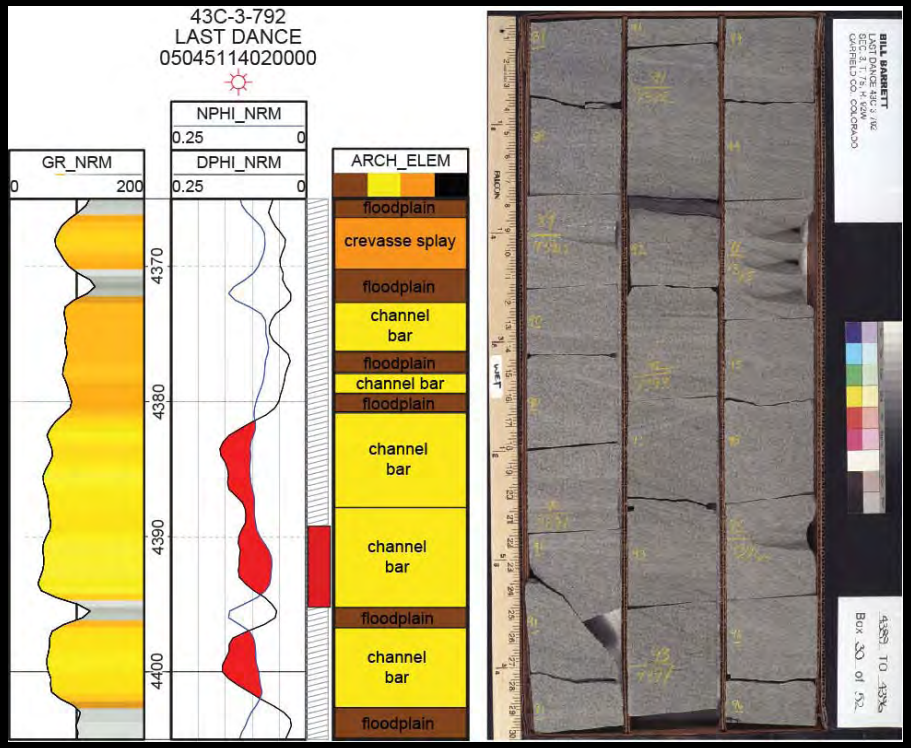
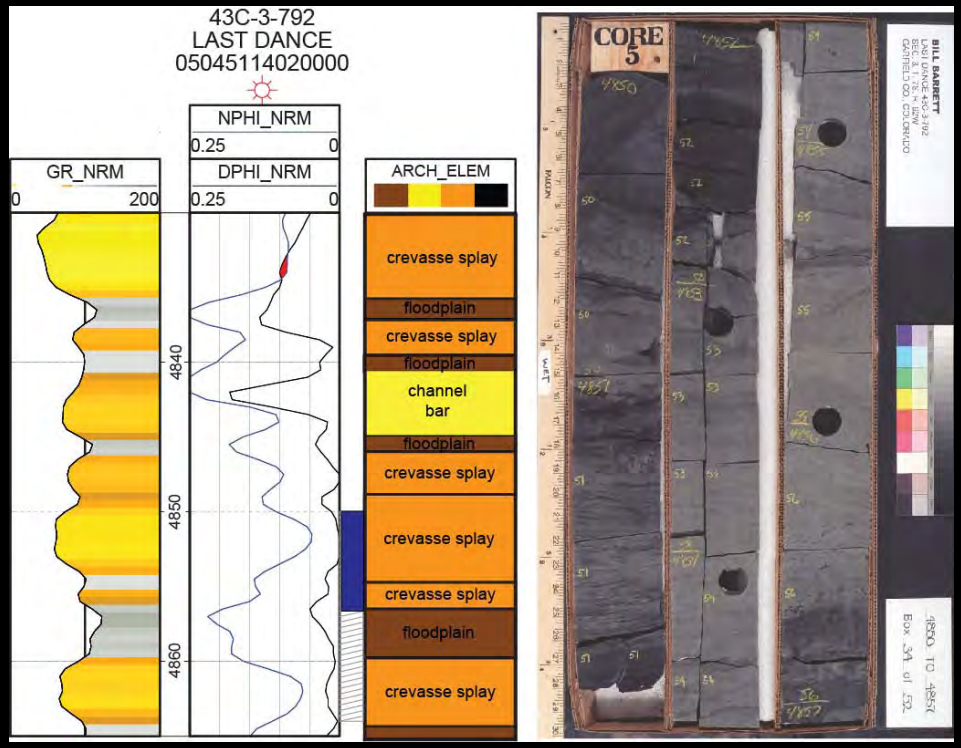
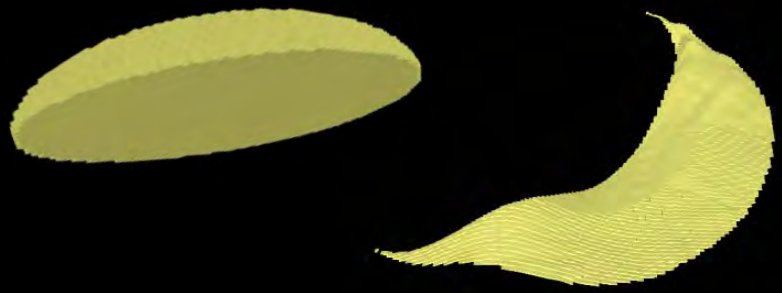
## Channel Bar / Point Bar




## Crevasse Splay



# Vertical Constraint: Vertical Proportion Curves

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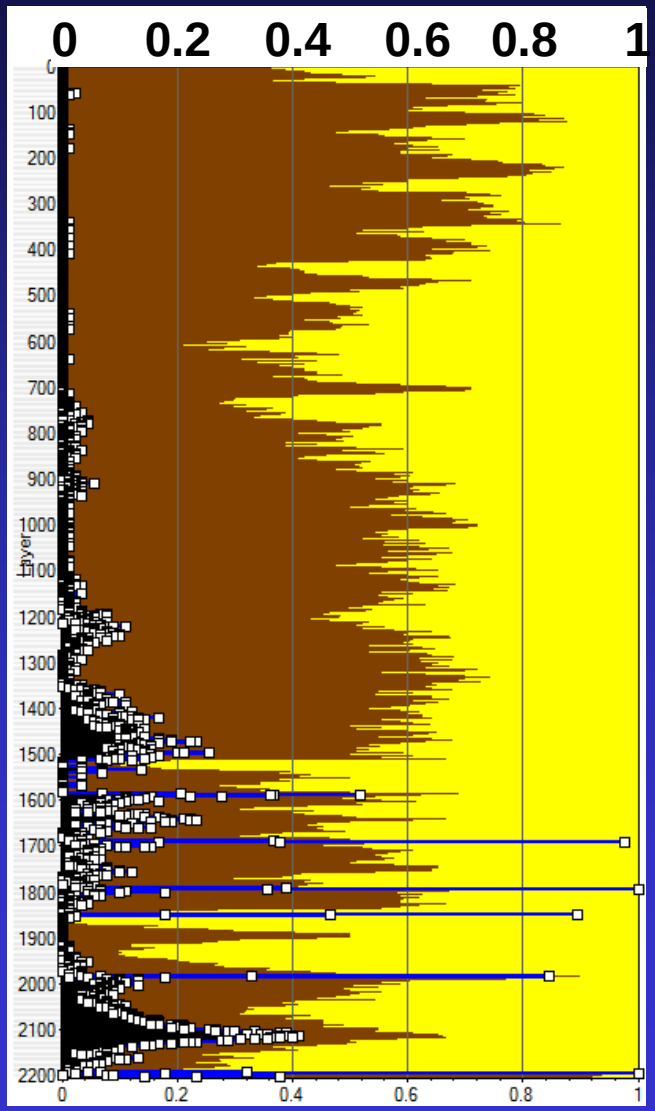
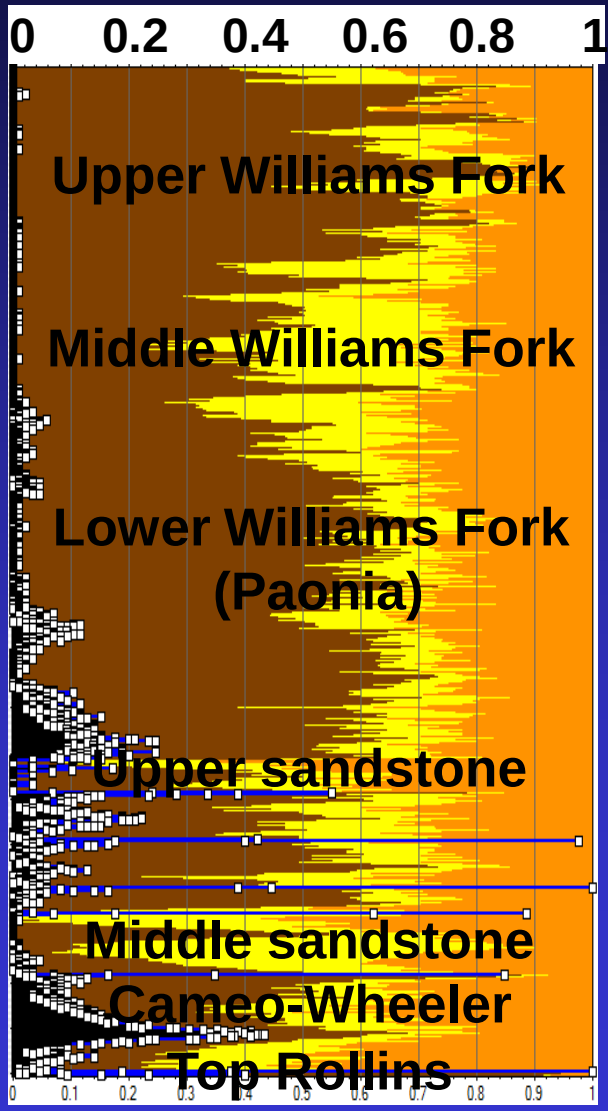
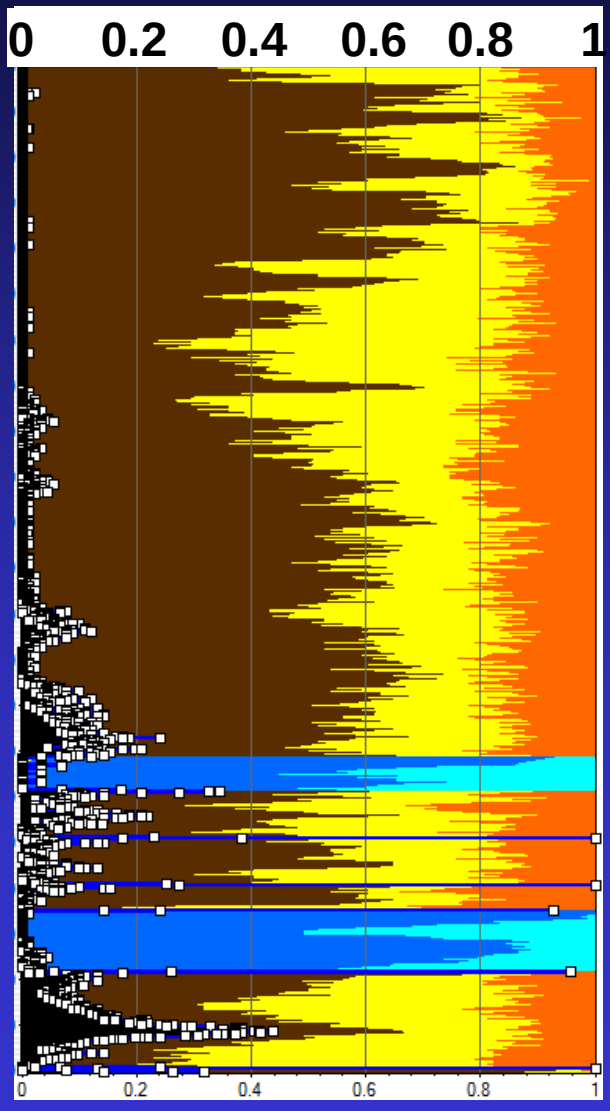
## Basic Lithology



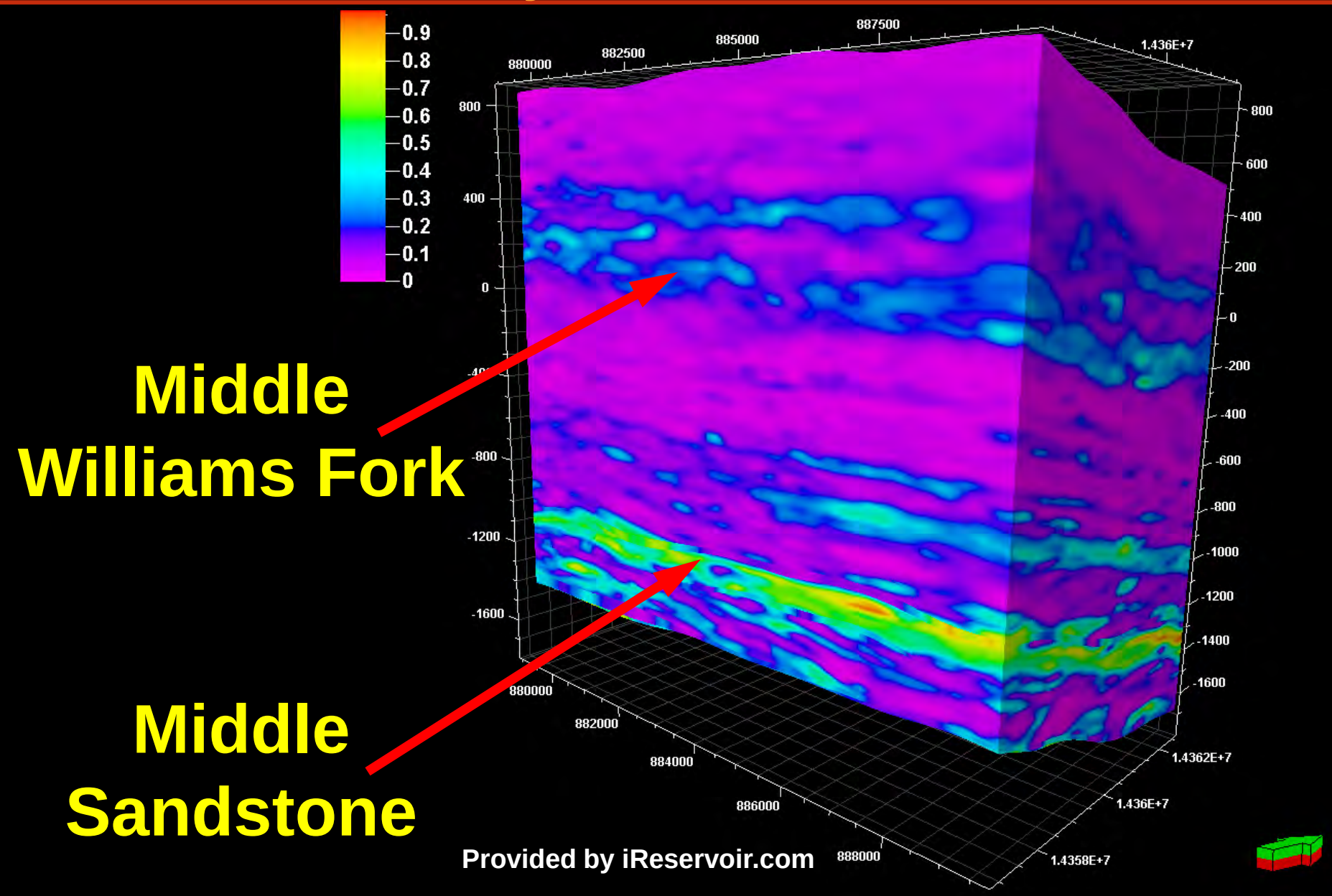

## Refined Lithology




## Architectural elements



# 3-D Spatial Constraint: Seismic Probability Volume




Provided by iReservoir.com

# 3-D Lithology Modeling and 3-D Architectural-Element Modeling

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**Sequential-indicator simulation (SIS) of basic lithology**

- Sandstone, mudstone, coal modeled
- **With 3-D seismic-based spatial probability constraint**

**Sequential-indicator simulation (SIS) of refined lithology**

- Clean sandstone, shaley sandstone, mudstone, and coal modeled

**Object-based simulation constrained to lithology**

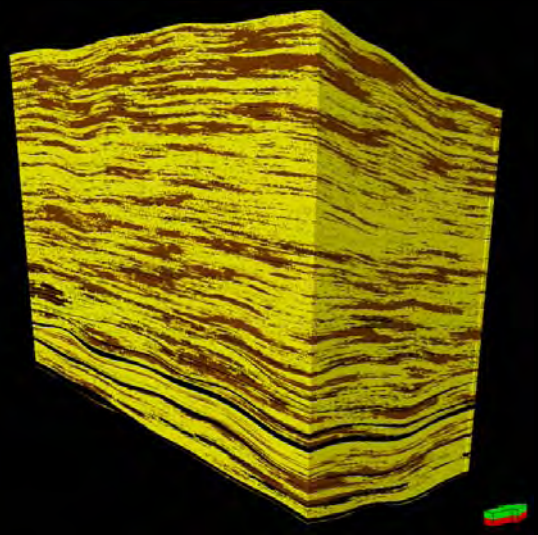
- Constrained to outcrop dimensional statistics for fluvial architectural elements (Pranter et al., 2009)

**Object-based simulation constrained to architectural elements**

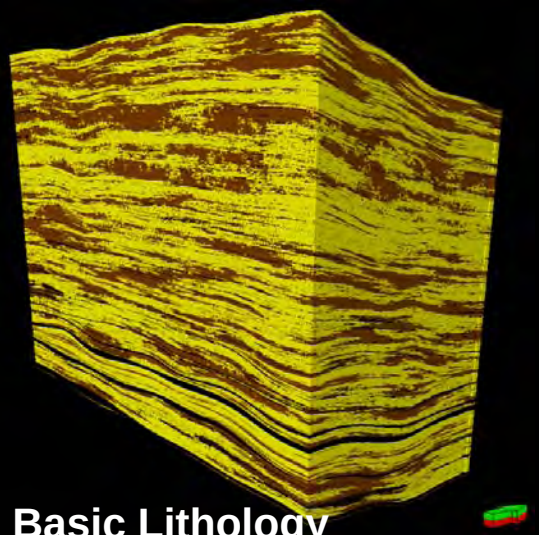
- Constrained to outcrop dimensional statistics for fluvial architectural elements (Pranter et al., 2009)

# Modeling Examples

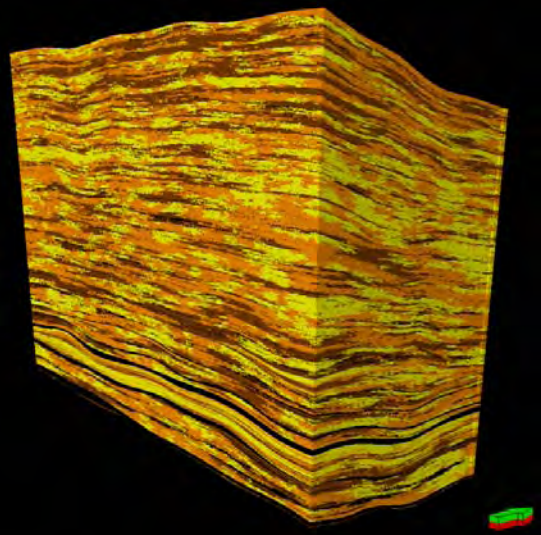
RCML



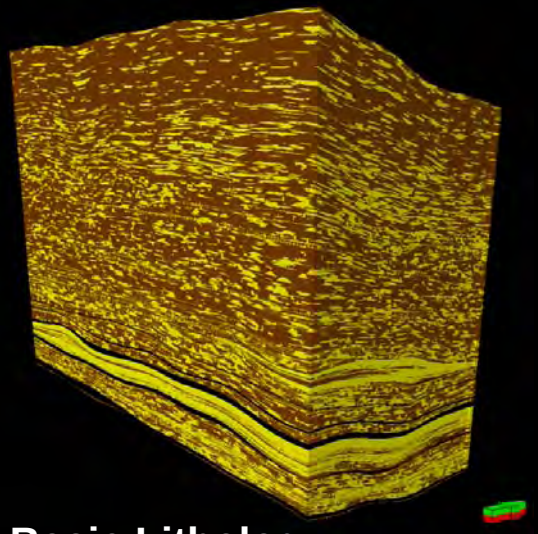
Basic Lithology



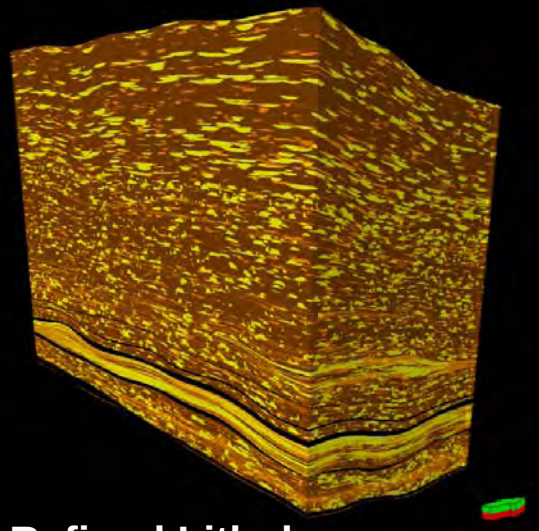
Basic Lithology
w/ 3-D seismic constraint



Refined Lithology



Basic Lithology



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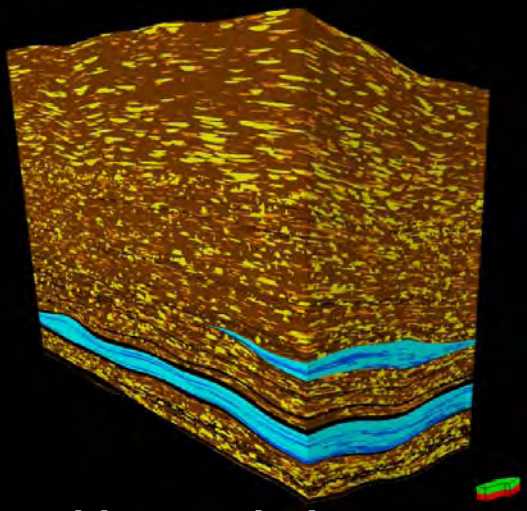

Architectural Elements

# Future Modeling work

- **Petrophysical modeling**
  - Porosity
  - Permeability (conventional core data)
- **Channel cluster analysis**
- **Static sandstone-body connectivity**

# 3-D Seismic Interpretation

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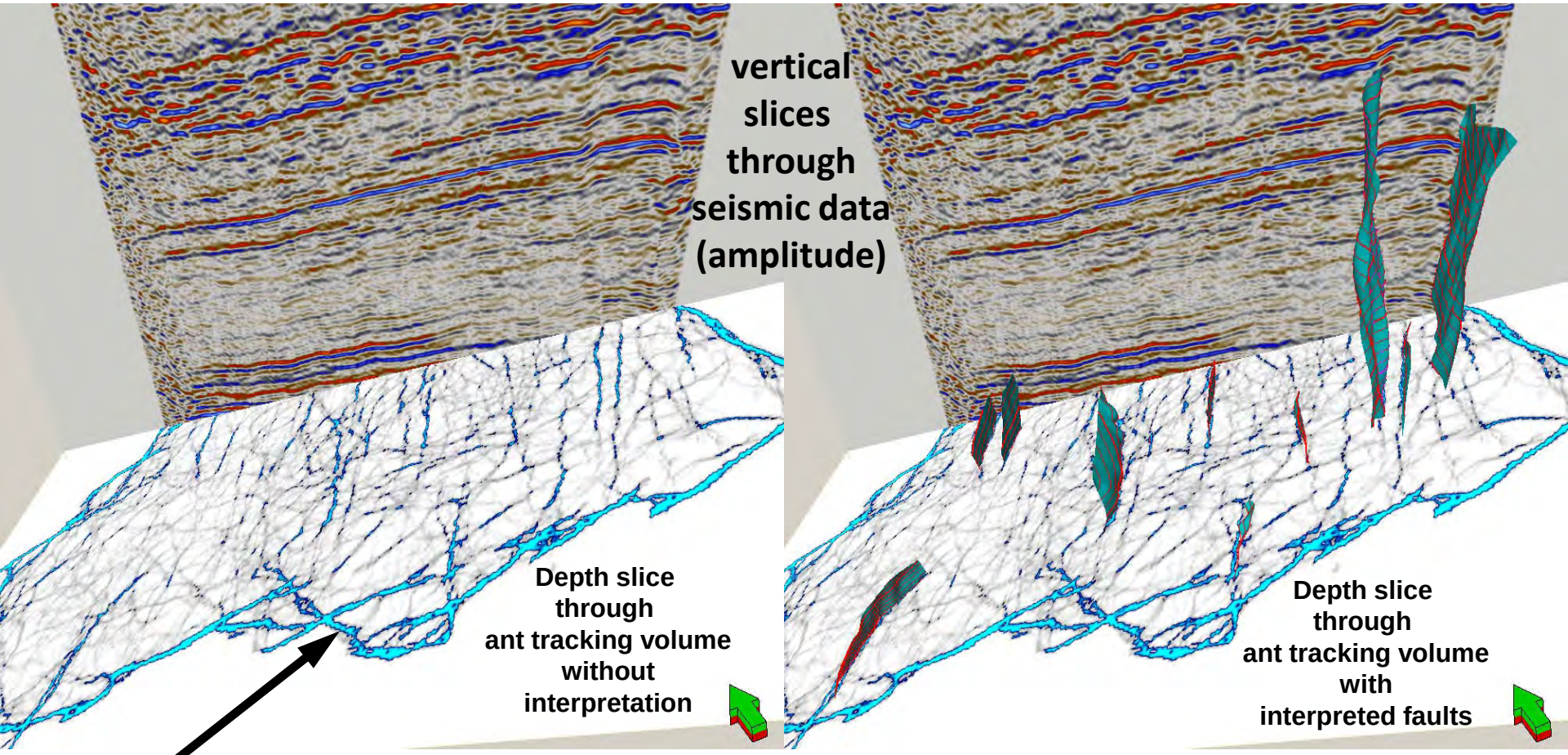
## Uninterpreted

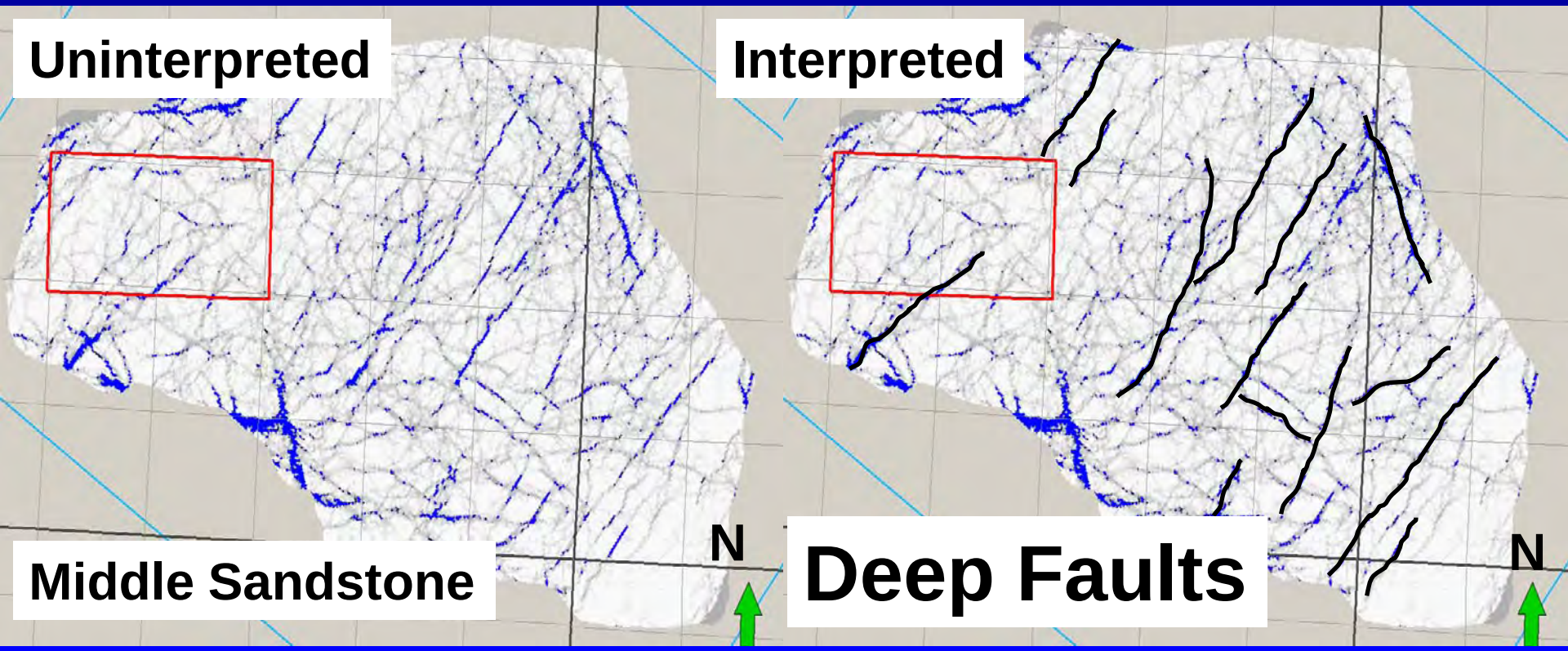
## Interpreted




Noise on survey edge

# 3-D Seismic Interpretation

- Fault interpretation based on seismic amplitude, ant-tracking results, and curvature attributes
- Two near-vertical fault sets (shallow faults strike N60W; deep faults strike N45E)



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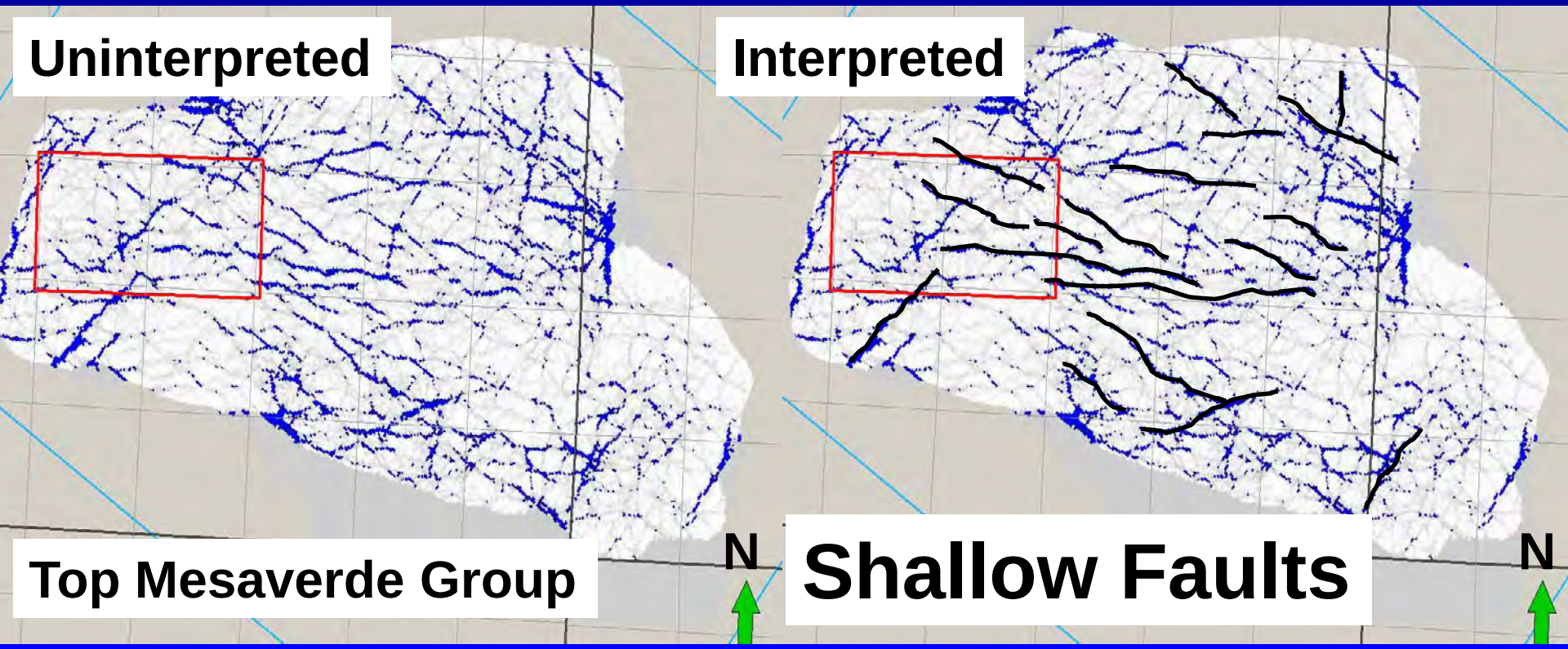

# Fracture / Seismic Attribute Analysis

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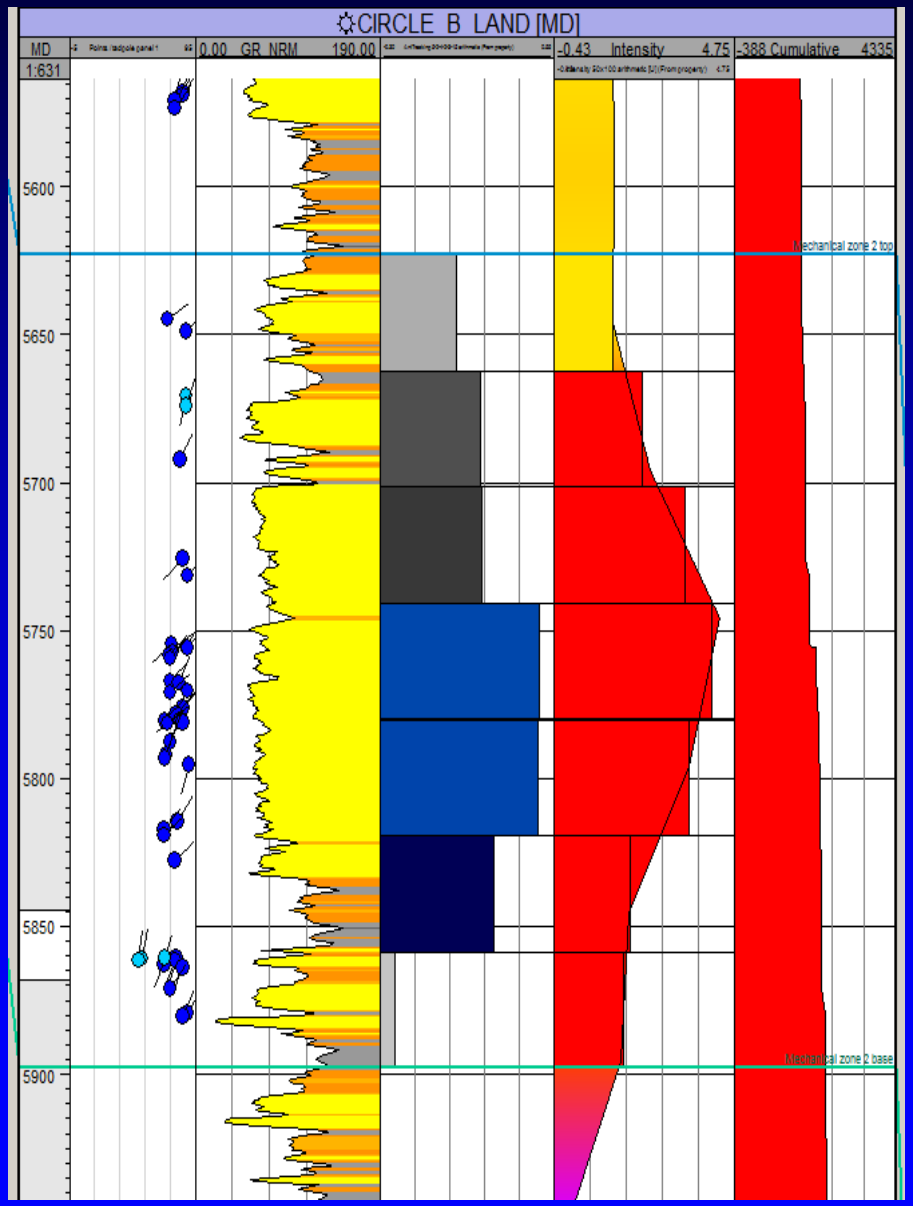
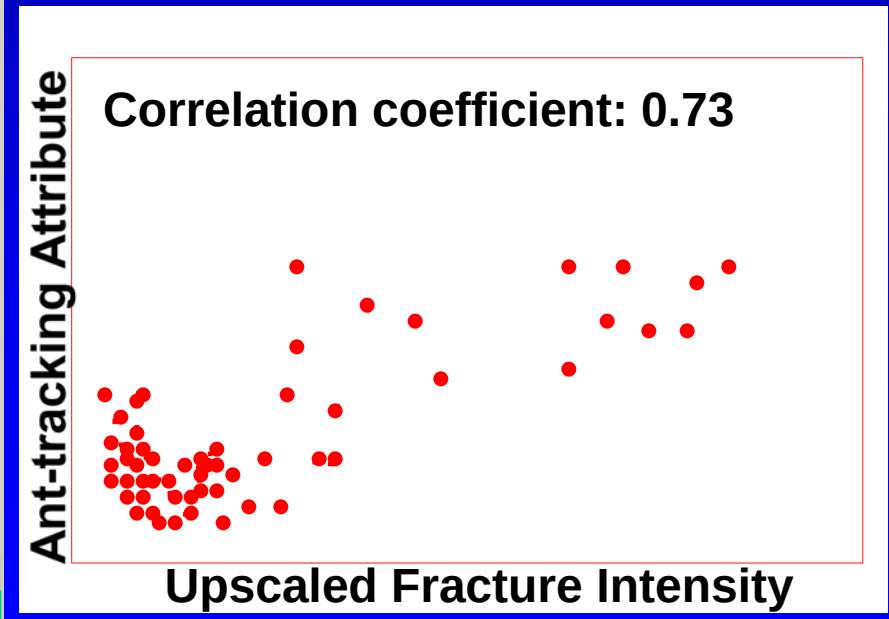
Fractured Zone




Relationship between ant tracked seismic attribute and fracture intensity in fractured zones



# Fracture Analysis and DFN Modeling

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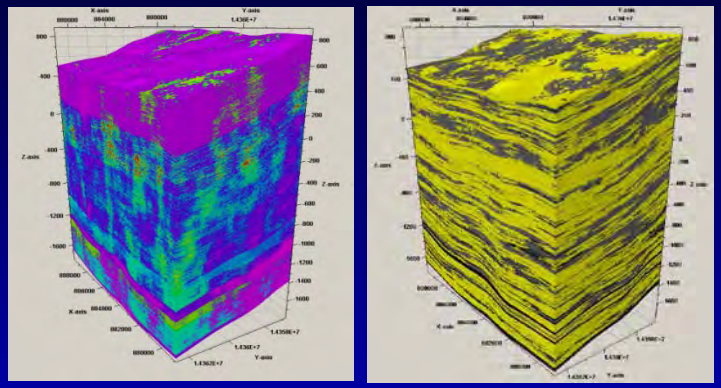
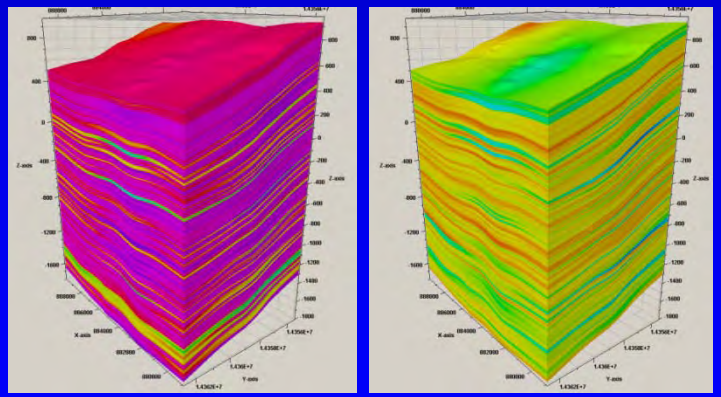
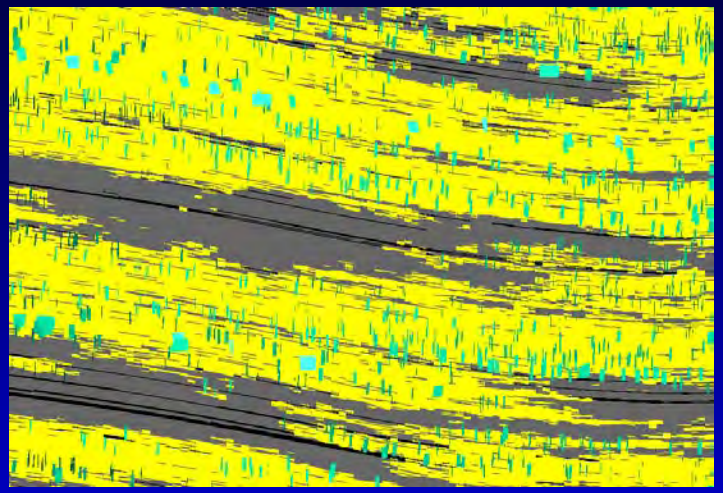


Fracture Intensity and Lithology

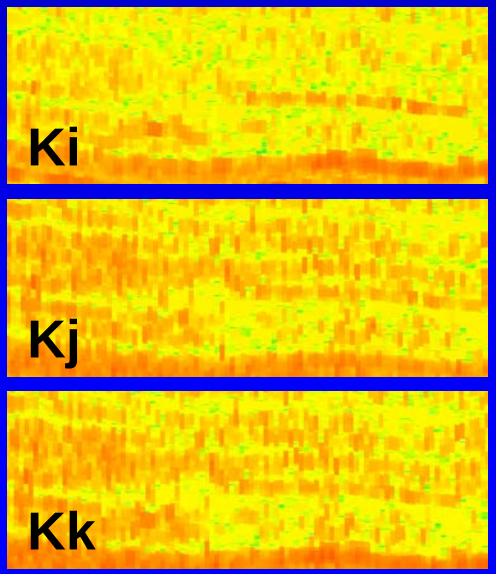
+



Fracture Dip Angle and Dip Azimuth



DFN (discrete fracture network) model




Scale up fracture properties